

A CATALOGUE OF SOUTH AUSTRALIAN FRESHWATER FISHES, INCLUDING NEW RECORDS, RANGE EXTENSIONS AND TRANSLOCATIONS

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Summary

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Published data, recent surveys and studies of museum specimens are combined to provide a list of 84 fishes for South Australia in five drainage divisions. The list includes 58 native species (44 restricted to freshwater) and 26 alien species. Seven endemics are recognised, namely *Chlamydogobius eremius* (Zeitz), *Chlamydogobius gloveri* Larson, *Craterocephalus dalhousiensis* Ivanstoff & Glover, *Craterocephalus eyresii* (Steindachner), *Craterocephalus gloveri* Crowley & Ivanstoff, *Mogurnda thermophila* Allen & Jenkins and *Neosilurus gloveri* Allen & Feinberg. New records are reported for *Craterocephalus stercusmuscarum*? *stercusmuscarum* (Günther), *Galaxias truttaceus* Valenciennes and *Neochanna cleaveri* (Scott), and a terapontid of uncertain status also is noted. Range extensions are reported for *Nannoperca obscura* (Klunzinger), *Nannoperca australis* Günther and an undescribed species of *Hypseleotris*, and the presence of *Galaxias olidus* Günther and *Galaxias brevipinnis* Günther in particular regions is confirmed. Possible extirpations are reported for *Ambassis agassizii* Steindachner, *Gadopsis marmoratus* Richardson, *Galaxias rostratus* Klunzinger, *Maccullochella macquariensis* (Cuvier), *Macquaria australasica* Cuvier, *Mogurnda adspersa* (Castelnau), *Neochanna cleaveri* and *Prototroctes maraena* Günther. There is need for further evaluations of fish distributions, better systematic frameworks, clarifications of conservation status, reviews of the introduction and impacts of alien species and development of protective measures for fish species and communities and their ecosystems.

KEY WORDS: Freshwater fishes, conservation, management, taxonomy

Introduction

Despite a generally dry landscape, South Australia harbours a diverse array of aquatic habitats including artesian mound springs, swamps, lakes, episodic streams and the River Murray and associated wetlands. These habitats, and the effects of biogeographical isolation (e.g. Unmack 2001), sustain a corresponding diversity of freshwater biota. The term "fresh water" here includes inland saline waters (≥ 3000 mg L⁻¹), as these are common in the state (e.g. Williams 1967; EPA 1998; Hammer 2002a).

Freshwater fishes in South Australia display a variety of physical forms and life histories. The dwarf galaxias *Galaxiella pusilla* is remarkable for its ability to survive dry periods in seasonal swamps, where it takes refuge in swamp-crayfish burrows (*Geocharax*: Beek 1985). Large species like the Murray-Darling golden perch *Macquaria ambigua ambigua* may cover long distances (for example, a tagged fish is known to have travelled 2300 km along the Murray and Darling rivers: Reynolds

1983), whereas small species like the southern pygmy perch *Nannoperca australis* are much less vagile (Hammer¹). Other species need to move between fresh water and marine habitats, although even diadromous species like the galaxiids *Galaxias maculatus* and *G. brevipinnis* may occur in 'landlocked' populations (Pierce *et al.* 1985; Hammer 2002a; SKM 2002). In addition, there are euryhaline species like the small-mouthed hardyhead *Atherinosoma microstoma*, found in fresh or salt water (Molsher *et al.* 1994; Hammer 2002a).

This catalogue lists 84 species in the freshwater fish fauna of South Australia. It updates earlier work (Waite 1923; Scott *et al.* 1974; Sim 2000), corrects and amends records of species and their distributions, and is designed to assist in research and planning for management and conservation.

Methods

Drainage divisions

Five of the 13 principal drainage divisions in Australia (AWRC 1976) occur wholly or partly in South Australia, and provide a biogeographic framework (Fig. 1):

- South East Coast (SEC), including the Millicent Coast and Glenelg River (part) river basins,
- Murray Darling (MD), part of the Lower Murray River Basin,
- South Australian Gulf (SAG), the only division contained wholly within the state (the shared

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¹ HAMMER, M. (2001) Molecular systematics and conservation biology of the southern pygmy perch *Nannoperca australis* (Günther, 1861) (Teleostei: Percichthyidae) in south-eastern Australia. Unpub. BSc(Hons) Thesis, Department of Environmental Biology, The University of Adelaide.

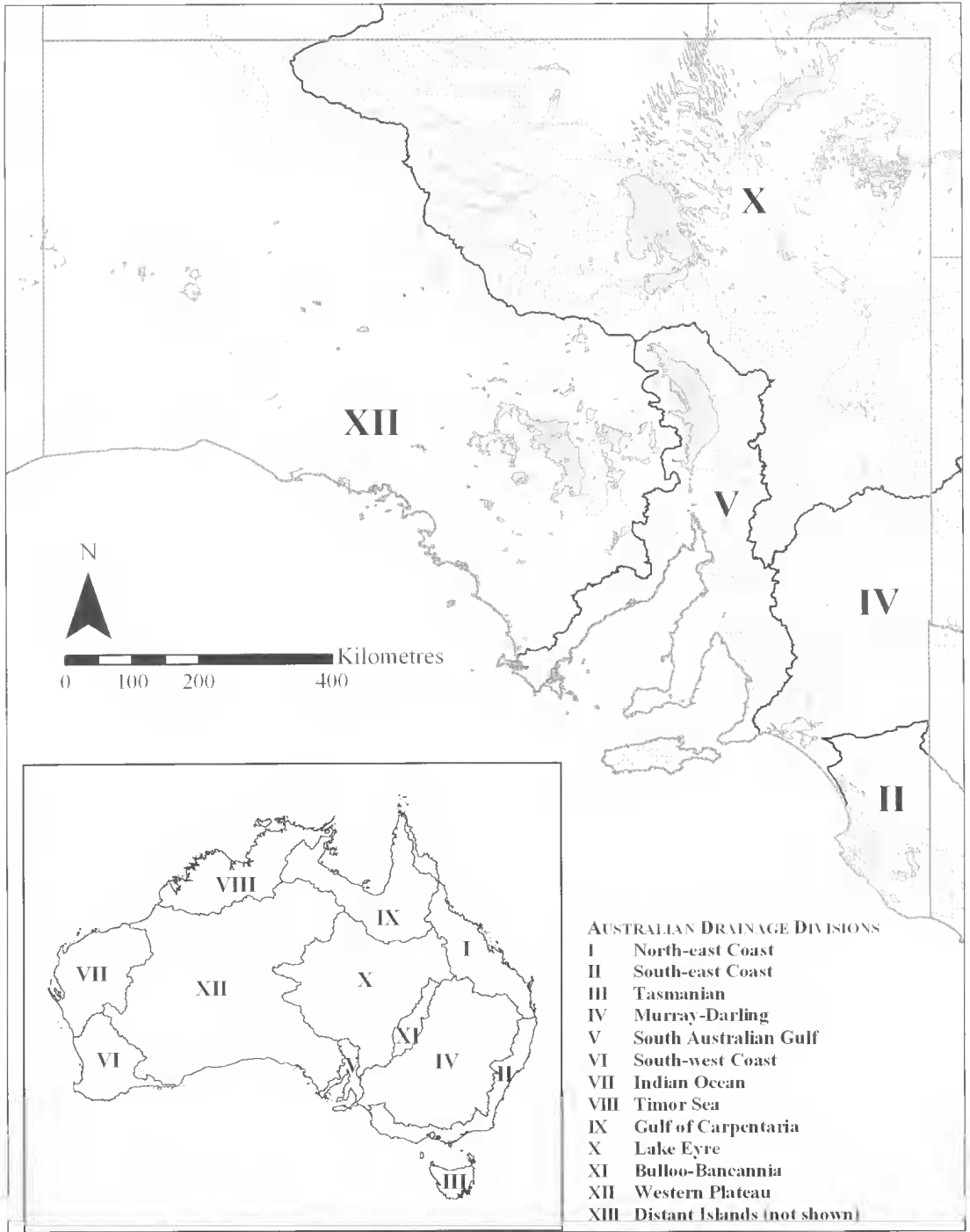


Fig. 1. Drainage divisions in Australia and South Australia (AWRC 1976).

boundary with MD is west of the Murray Mouth, but SAG includes the coastal streams of Fleurieu Peninsula),

- Lake Eyre (LE), draining toward lakes Eyre and Frome, and
- Western Plateau (WP), containing sparse coastal lakes and some ephemeral waters.

Records of species were obtained from the literature and examination of specimens at the South Australian Museum, Adelaide (SAMA), including material from recent collections by the senior author. Information on rare or doubtful species was scrutinised with special care.

Nomenclature

The systematic framework and nomenclature employed here follow Eschmeyer (1998) and subsequent updates (see Californian Academy of Sciences on-line "Catalogue of Fishes", March 2003²), except that the lamprey families Geotriidae and Mordaciidae replace Petromyzontidae (Strahan 1980), subspecific status is recognised for *M. a. ambigua* (after Musyl & Keenan 1992) and six informal taxa and a species complex are recognised. The informal taxa include dwarf flathead gudgeon *Philypnodon* sp. (Larson & Hoese 1996), Lake Eyre golden perch *Macquaria* sp. (Musyl & Keenan 1992) and western chanda perch, an undescribed species referred to in earlier literature as "*Ambassis muelleri* Klunzinger" (syn. *A. agassizii*), but lacking a formal name since "*A. muelleri*" was invalidated by Allen *et al.* (2002). The carp gudgeon genus *Hypseleotris* awaits a formal review but, following Allen *et al.* (2002), this catalogue recognizes Midgley's carp gudgeon *H.* "sp. 1" *sensu* Hoese *et al.* (1980) and Murray-Darling carp gudgeon *H.* "sp. 3" *sensu* Unmack (2000). In addition, a species complex of hybrids and possible semi-clonal hybridogenic forms are recognised (Bertozzi *et al.* 2000), including Lake's carp gudgeon *H.* "sp. 2" *sensu* Hoese *et al.* (1980). Following Allen and Jenkins (1999), prior records of northern purple-spotted gudgeon *Mogurnda mogurnda* (Richardson) in South Australia should be referred to Dalhousie purple-spotted gudgeon *M. thermophila* or Flinders Ranges purple-spotted gudgeon *M. clivicola* (these were described from within the range of *M. mogurnda*).

Criteria for inclusion

A "freshwater" species here includes obligate freshwater and diadromous species and select euryhaline taxa known to complete their lifecycle in fresh water. "Alien" species include exotic species (not native to Australia) and native Australian

species translocated outside their natural range. Alien fishes in natural waterways are regarded as *established* species if their populations are self-sustaining or if they are continually stocked, and as *introduced* species if records are few and isolated or confined to artificial waterbodies (and potentially could become established). The latter include interstate translocations within drainage divisions.

Results

Native fish richness

A total of 58 native freshwater fish species in 15 families is recorded for South Australia (Table 1). All are shared with other states, except for seven endemics in isolated areas of LE. *Mogurnda clivicola* may be another endemic, as only small populations of uncertain affinity occur outside the state (Allen & Jenkins 1999; Wager & Unmack 2000).

Forty-four native species are confined to fresh water. One of these, Australian smelt *Retropinna semoni*, may occasionally occur in the Coorong (Eckert & Robinson 1990), but is not strictly diadromous. Four euryhaline taxa meet the aforementioned criteria of "freshwater" species, namely *A. microstoma*, flathead gudgeon *Philypnodon grandiceps*, western bluespot goby *Pseudogobius olorum* and lagoon goby *Tasmanogobius lasti* (e.g. Wedderburn & Hammer 2003). Thirteen of the 44 obligate freshwater species occur in more than one division, and none is common to all. Most obligate freshwater species occur in LE (24) and MD (24), plus 11 diadromous and euryhaline taxa. Diadromous and euryhaline species generally occur in more than one division. Remarkably, three diadromous species are recorded for WP, although data there are sparse (Table 1).

New records for South Australia

Fly-specked hardyhead *Craterocephalus stercusuuscarum* *?stercusuuscarum* (Günther)

This taxon was identified in samples collected from the northern Flinders Ranges in 1994-95 (SAMA F7331, F9002, F9078). It is distinguished from the Lake Eyre hardyhead *Craterocephalus eyesii* (Steindachner), which occurs in the same region but not the same habitats, by fewer transverse scale rows (7-8 cf. 11-14 in *C. eyesii*) and dark lateral banding (Ivanstovff *et al.* 1987; Crowley & Ivanstovff 1990a). Subspecific identification is tentative owing to taxonomic problems and the isolated nature of the population (the nearest known conspecifics are from Aramac Springs in the remote

² <http://www.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>

TABLE 1. Native freshwater fishes in drainage divisions of South Australia. [X = recorded; E = presumed extinct; ? = uncertain status], #Endemic to South Australia. *See text.

Family	Taxon	Common name	SEC	Division			
				MD	SAG	LE	WP
Geotriidae	<i>Geotria australis</i> Grey, 1851	Pouched lamprey	X	X	X		
	<i>Mordax mordax</i> (Richardson, 1846)	Shorthanded lamprey	X	X	X		
	<i>Anguilla australis</i> Richardson, 1841	Shortheaded lamprey	X	X	X		
Anguillidae	<i>Neosiluroides cooperensis</i> Allen & Feinberg, 1998	Cooper catfish				X	
	<i>Neosilurus gloveri</i> Allen & Feinberg, 1998#	Dalhousie catfish				X	
	<i>Neosilurus hyrtlilii</i> Steindachner, 1867	Hyrtl's catfish				X	
Plotosidae	<i>Porochilus argenteus</i> (Zieth, 1896)	Silver tandan				X	
	<i>Tandanus tandanus</i> Mitchell, 1838	Freshwater catfish		X			
	<i>Nematolosa erebi</i> (Günther, 1868)	Bony herring		X	?		
Clupeidae	<i>Protiroctes maraena</i> Günther 1864	Australian grayling	E				X
	<i>Retropinna semoni</i> (Weber, 1895)	Australian smelt		X			X
	<i>Galaxias brevipinnis</i> Günther, 1866	Climbing galaxias		X	X		X
Retropinnidae	<i>Galaxias maculatus</i> (Jenyns, 1842)	Common galaxias	X	X	X		X
	<i>Galaxias olidus</i> Günther, 1866	Mountain galaxias	X	X	X		X
	<i>Galaxias rostratus</i> Klunzinger, 1872	Murray galaxias		E			
Galaxiidae	<i>Galaxias truttaceus</i> Valenciennes, 1846	Spotted galaxias	X				
	<i>Galaxiella pusilla</i> (Mack, 1936)	Dwarf galaxias	X				
	<i>Neochanna cleaveri</i> (Scott, 1934)	Tasmanian mudfish	X				
Melanotaeniidae	<i>Melanotaenia fluviatilis</i> (Castelnau, 1878)	Murray rainbowfish	?	X			
	<i>Melanotaenia splendida tatei</i> (Zieth, 1896)	Desert rainbowfish				X	
	<i>Atherinosoma microstoma</i> (Günther, 1861)	Small-mouthed hardyhead	X	X	X		X
Atherinidae	<i>Craterocephalus dalhousiensis</i> Ivanstöff & Glover, 1974#	Dalhousie hardyhead				X	
	<i>Craterocephalus eyesii</i> (Steindachner, 1883)#	Lake Eyre hardyhead				X	
	<i>Craterocephalus fluviatilis</i> McCulloch, 1912	Murray hardyhead		X			
Ambassidae	<i>Craterocephalus gloveri</i> Crowley & Ivanstöff, 1990#	Glover's hardyhead		X			
	<i>Craterocephalus stercusmuscarum</i> Ivanstöff, Crowley & Allen, 1987	Unspecked hardyhead		X			
	<i>Craterocephalus stercusmuscarum</i> ? <i>stercusmuscarum</i> (Günther, 1867)	Fly-specked hardyhead		E			
Percichthyidae	<i>Ambassis</i> sp. (undescribed)†	Chanda perch				X	
	<i>Gadopsis marmoratus</i> Richardson, 1848	Western chanda perch	X	X	E		
	<i>Maccullochella macquariensis</i> (Cuvier, 1829)	River blackfish		E			
Macquariidae	<i>Maccullochella peelii peellii</i> (Mitchell, 1838)	Murray cod		X			
	<i>Macquaria ambigua ambigua</i> (Richardson, 1845)	Murray-Darling golden perch		X			
	<i>Macquaria australasica</i> Cuvier, 1830	Macquarie perch		E			
Nannoperca	<i>Macquaria colonorum</i> (Günther, 1863)	Estuary perch	X	X			
	<i>Macquaria</i> sp. (undescribed)†	Lake Eyre golden perch		X			X
	<i>Nannoperca australis</i> Günther, 1861	Southern pygmy perch	X	X			X
Nannoperca	<i>Nannoperca obscura</i> (Klunzinger, 1872)	Yarra pygmy perch	X	X			

Family	Taxon	Common name	Division					
			SEC	MD	SAG	LE	WP	
Terapontidae	<i>Nannoperca variegata</i> Kuitert & Allen, 1986	Variegated pygmy perch	X					
	<i>Ammatataba percooides</i> (Günther, 1864)	Banded grunter				X		
	<i>Bichyanus bichyanus</i> (Mitchell, 1838)	Silver perch		X				
	<i>Bichyanus welchi</i> (McCulloch & Waite, 1917)	Welch's grunter				X		
	<i>Leiopotherapon unicolor</i> (Günther, 1859)	Spangled grunter		X	?	X		
	<i>Scortum barcoo</i> (McCulloch & Waite, 1917)	Barcoo grunter				X	X	
	<i>Pseudaphritis urvillii</i> (Valenciennes, 1832)	Congolli	X	X	X			
	<i>Hypseleotris klunzingeri</i> (Ogilby, 1898)	Western carp gudgeon		X		X		
	<i>Hypseleotris</i> sp. 1 (undescribed)*	Midgley's carp gudgeon		X		X		
	<i>Hypseleotris</i> sp. 3 (undescribed)*	Murray Darling carp gudgeon		X	X			
	<i>Hypseleotris</i> spp. (species complex)*	Hybrid forms (e.g. Lake's carp gudgeon)		X		X		
	<i>Mogurnda adpersa</i> (Castelnau, 1878)	Southern purple-spotted gudgeon		E	E			
	<i>Mogurnda clivicola</i> Allen & Jenkins, 1999	Flinders Ranges purple-spotted gudgeon				X		
<i>Mogurnda thernophila</i> Allen & Jenkins, 1999*	Dalhousie purple-spotted gudgeon				X			
<i>Philypnodon grandiceps</i> (Krefft, 1864)	Flathead gudgeon	X	X	X				
<i>Philypnodon</i> sp. (undescribed)*	Dwarf flathead gudgeon		X					
<i>Chlamydogobius eremius</i> (Zeitz, 1896)#	Desert goby				X			
<i>Chlamydogobius gloveri</i> Larson 1995#	Dalhousie goby				X			
<i>Pseudogobius olorum</i> (Sauvage, 1880)	Western bluespot goby	X	X	X		X		
<i>Tasmanogobius lasri</i> Hoese, 1991	Lagoon goby	X	X	X				
Totals (Grand Total 58)			19	35	16	24	3	

upper reaches of Cooper Creek, Queensland). A molecular revision of *Craterocephalus* in progress indicates that sub-species within the *C. stercusmuscarum* species complex remain confused (P. Unmack, Arizona State University, pers. comm.) and further morphological and molecular analyses are required.

Spotted galaxias *Galaxias truttaceus* Valenciennes

This species was first reported in 1999 from karstic springs in coastal south-eastern South Australia (e.g. Ewens Ponds: Hammer *et al.* 2000; SAMA F9217, F10111) representing a minor westward range extension into South Australia. Another single specimen from the same area occurred among specimens of *G. maculatus* collected in 1979 (SAMA F10109). Note that a prior report of *G. truttaceus* from SAG (Scott *et al.* 1974) was based on misidentified specimens (SAMA F3094, F3188).

Tasmanian mudfish *Neochanna cleaveri* (Scott)

This species is known in South Australia only from a single specimen collected from Bool Lagoon in 1974, and previously registered as *G. maculatus* (SAMA F4919). Recent surveys have failed to locate others (Hammer 2002a). The new record is noteworthy as the species is cryptic, with an ability to survive extended dry periods by burrowing into mud or hiding under rocks and wood, and otherwise is native to Tasmania and Victoria (Fulton 1986; Kochn & Raadik 1991).

A possible new terapontid

A form of grunter (Terapontidae) resembling a deep-bodied Welch's grunter *Bidyanus welchi* or a hybrid *B. welchi* x Barcoo grunter *Scortum barcoo* is known from Coongie Lakes (J. Puckridge, University of Adelaide, pers. comm. 2001). This form is listed as the 'Cooper grunter' by Sim (2000). It was also reported near Goyder Lagoon on the lower Warburton River in 2002 (Costelloe *et al.* 2003).

Range extensions

Surveys in the Mount Lofty Ranges (Hammer¹) have provided three new drainage division records, namely a genetically distinct sub-population of *Nanuoperca australis* from the Inman River Catchment (SAG), *Hypseleotris* sp. 3 from the same location, and Yarra pygmy perch *Nanuoperca obscura* from Lake Alexandrina (MD). The review uncovered other, previously misidentified specimens

of *N. obscura* in the museum collection dating from 1915 (SAMA F572), suggesting the species is native.

The presence of mountain galaxias *Galaxias olidus* (a species complex presently under systematic review: Raadik 2001) recently was confirmed from the South Australian section of SEC (Mosquito Creek: Hammer 2002a). Despite its inclusion in a south east regional list by Glover (1983), no specimens of the species were previously known. In addition, Glover mistakenly referred to the Mosquito Creek population as *G. maculatus*. The presence of *G. brevipiinnis* in MD is also confirmed (SAMA F153; Angas River, 1914; previously registered as *G. maculatus*), a record predating the Snowy Mountains Hydroelectric Scheme which appears to be the source of *G. brevipiinnis* in the upper Murray catchment (Waters *et al.* 2002).

A report of *R. semotii* from SAG (SKM 2002) is suspect because voucher specimens are not available and no other records exist for the division (e.g. McDowall 1979; Unmack 2001). Other SAG reports of bony herring *Nematalosa erebi* and spangled grunter *Leiopotherapon unicolor* in the Lake Torrens catchment, and western carp gudgeon *Hypseleotris kluzingeri* as native to the Broughton River (Pierce *et al.* 2001) are also discounted in the absence of voucher specimens or other data. There is an uncertain report of fish resembling *C. eyesii* in the remote, isolated Durkin Swamp (WP), following exceptional rainfall (Ehmann & Tynan 1997).

Finke goby *Chlaudydogobius japalpa* Larson, Finke hardyhead *Craterocephalus centralis* Crowley & Ivanstoft and Finke purple-spotted gudgeon *Mogurnda larapiutae* (Zeit) potentially could colonise the ephemeral, lower reaches of the Finke River in South Australia, following floods from the headwaters in the Northern Territory, but they have not been formally recorded.

Alien species

There are records of 26 alien species in South Australia (Tables 2-3), although two may prove to be natives (*Philypnodon* sp. from the Onkaparinga River (SAG) (SAMA F10087, April 2002), and Murray rainbowfish *Melanotaenia fluviatilis* from SEC (SAMA F2409, dated 1903)). Most alien species records are for SAG (20 species, including 13 established alien species). There are high numbers also for MD and SEC, but few in the remote LE and WP (Table 2).

Fourteen alien species are established in South Australia. These include seven exotic taxa and seven translocated native taxa. Another 12 alien species have been introduced, but are not established or present only in artificial waterways (Tables 2-3). These include barramundi *Lates calcarifer* in the River Torrens and Australian bass *Macquaria*

TABLE 2. *Alien fishes in fresh water environments in drainage divisions of South Australia.* [X = continually introduced and/or established; I = introduced, few records; A = introduced to artificial habitats (e.g. farm dams, sewage treatment ponds); ? = uncertain status]. †See text.

Family	Taxon	Common name	Division				
			SEC	MD	SAG	LE	WP
EXOTIC SPECIES							
Cyprinidae	<i>Carassius auratus</i> (Linnaeus, 1758)	Goldfish	X	X	X	X	A
	<i>Cyprinus carpio</i> Linnaeus, 1758	Common carp	I	X	X	X	A
	<i>Tinca tinca</i> (Linnaeus, 1758)	Tench	X	X	X		
Cobitidae	<i>Misgurnus anguillicaudatus</i> (Cantor, 1842)	Oriental weatherloach		I			
	<i>Oncorhynchus mykiss</i> (Walbaum, 1792)	Rainbow trout	I	X	X		
Salmonidae	<i>Salmo salar</i> Linnaeus, 1758	Atlantic salmon		I			
	<i>Salmo trutta</i> Linnaeus, 1758	Brown trout	I	X	X		
Poeciliidae	<i>Salvelinus fontinalis</i> (Mitchell, 1814)	Brook trout		X	I		
	<i>Gambusia holbrooki</i> Girard, 1859	Gambusia	X	X	X	X	I
Percidae	<i>Percu fluviatilis</i> Linnaeus, 1758	European perch	X	X	X	X	I
TRANSLOCATED AUSTRALIAN NATIVE SPECIES							
Plotosidae	<i>Tandanus tandanus</i> (Mitchell, 1838)	Freshwater catfish	I	A	X		
	<i>Galaxiella pusilla</i> (Mack, 1936)	Dwarf galaxias	I?		I?		
Melanotaeniidae	<i>Melanotaenia fluviatilis</i> (Castelnau, 1878)	Murray rainbowfish	I?		X		
	<i>Lates calcarifer</i> (Bloch, 1790)	Barramundi			I		
Ambassidae	<i>Ambassis agassizii</i> Steindachner, 1867	Chanda perch		A			
	<i>Gadopsis marmoratus</i> Richardson, 1848	River blackfish			A		
Percichthyidae	<i>Maccullochella peelii pealii</i> (Mitchell, 1838)	Murray cod	I	A	X	I	
	<i>Macquaria ambigua ambigua</i> (Richardson, 1845)	Murray-Darling golden perch	I	A	X	A	
Teraponidae	<i>Macquaria novemaculeata</i> (Steindachner, 1866)	Australian bass		I			
	<i>Nannoperca australis</i> Günther, 1861	Southern pygmy perch			A		
Eleotridae	<i>Bidymanus bidyanus</i> (Mitchell, 1838)	Silver perch	I	A	A	A	
	<i>Hypseleotris</i> sp. 1 (undescribed)†	Miekeley's carp gudgeon			X		
Eleotridae	<i>Hypseleotris</i> sp. 3 (undescribed)†	Murray Darling carp gudgeon	X				
	<i>Mogurnda adspersa</i> (Castelnau, 1878)	Southern purple-spotted gudgeon		A	A		
Eleotridae	<i>Oxyeleotris lineolata</i> (Steindachner, 1867)	Sleepy cod		I			
	<i>Phlyptodon</i> sp. (undescribed)†	Dwarf flathead gudgeon			X?		
Totals (Grand Total 26)			13	17	20	7	2
Total established (Grand Total 14)			5	7	13	2	0

TABLE 3. *Distributions annotations for selected freshwater fishes in South Australia (in support of Tables 1-2). [Record types: 1 = range extension or new state record; 2 = restricted presence; 3 = established alien species; 4 = introduced; 5 = erroneous report], SA = South Australia; Vic. = Victoria; SAMA = South Australian Museum, Adelaide; AM = Australian Museum, Sydney; SMNS = Staatliches Museum für Naturkunde, Stuttgart, Germany*

Species	Record Details		Source
	Type		
SOUTH EAST COAST DRAINAGE DIVISION			
<i>Galaxias truttaceus</i>	1	Lower south east SA, springs and coastal creeks.	Hammer (2002a) = SAMA F9217; F10109 (1979) SAMA F4919 (1974)
<i>Neochanna cleaveri</i>	1	Specimen from Bool Lagoon labelled as <i>Galaxias maculatus</i> .	Hammer (2002a) = SAMA F10121
<i>Galaxias olidus</i>	2	Mosquito Creek. Referred to as <i>Galaxias maculatus</i> by Glover (1983).	Kuiter (1983); SAMA F1046 (1928)
<i>Galaxia australis</i>	2	Photographed in Ewens Ponds. Collected from Glenelg R. in SA.	SAMA F1704 (1932); Hammer (2002a)
<i>Macquaria colonorum</i>	2	Glenelg R. in SA.	F10103 (1982)
<i>Mordacia mordax</i>	2	Near Port MacDonnell. Other SAMA records from western Vic.	Kuiter (1983); Hammer (2002a)
<i>Prototroctes maruena</i>	2	Photographed in Ewens Ponds. No recent records.	Hammer (2002a)
<i>Tasmanogobius lasii</i>	2	Some freshwater lakes (e.g. L. Bonney).	Hammer (2002a)
<i>Hypseleotris</i> sp. 3	3	No records <1980; now widespread in Millicent Coast Basin.	Hammer (2002a); SAMA F10144
<i>Tinca tinca</i>	3	Naracoorte Creek, L. Cockatoo.	SAMA F7700 (1995); Hammer (2002a)
<i>Cyprinus carpio</i>	4	One record from Bool Lagoon (1995), unconfirmed report for Valley L.	Glover (1983); Hammer (2002)
<i>Oncorhynchus mykiss</i> and <i>Salmo trutta</i>	4	Mosquito Creek, Ewens Ponds. Previously stocked and/or farm escapees. No recent reports.	SAMA F1918 (1936); Atkins <i>et al.</i> (1988); Hammer (2002a)
<i>Tandanus tandanus</i>	4	Lucindale (1936). Stocked with <i>Bichyanus bichyanus</i> , <i>Maccullochella peelii peelii</i> , <i>Macquaria ambigua ambigua</i> .	SAMA F2409 (1903). Concurrent collections = SAMA F1901, 1368
<i>Melanotaenia fluviatilis</i>	4	Freshwater L. near Kingston and Robe with <i>Atherinosoma microstoma</i> and <i>Gadopsis narmoratus</i> . Could be native.	AM IB7303, 7304 cf. Glover (1983)
<i>Craterocephalus stercusmuscarum</i>	5	Mis-identified <i>Atherinosoma microstoma</i> .	Hammer (2002) cf. Atkins <i>et al.</i> (1988)
<i>Hypseleotris klanzingeri</i>	5	Probably <i>Hypseleotris</i> sp. 3, as above.	Hammer (2002a) cf. Larson & Hoese (1996)
<i>Philyponotus</i> sp.	5	Absent in region.	Hammer (2002a)
<i>Retropinna semoni</i>	5	Absent between Glenelg R. and the Murray.	
MURRAY DARLING DRAINAGE DIVISION			
<i>Nannoperca obscura</i>	1	L. Alexandrina (2001). SAMA specimens date from 1915.	Hammer ¹ = SAMA F10008 (2001); SAMA F572 (1915)
<i>Anguilla australis</i>	2	Occasional R. Murray records, also streams near L. Alexandrina. At western-most range for larval migration (inc. K.I. also, see SAG).	e.g. SAMA F3712 (1972); F7798 (1996)
<i>Galaxias brevipinnis</i>	2	Large adult from Angas R.	SAMA F153 (1914)
<i>Galaxias rostratus</i>	2	Syntypes (R. Murray SA) SMNS, some redeposited with AMS. Another specimen from Murray Bridge needs verification.	SMNS 1597 (1868), ?1696 (1869); AM 119743; McDowall and Frankenberg (1981)
<i>Leiopotherapon unicolor</i>	2	Coorong and L. Alexandrina in 1976 after floods.	SAMA F4152, F4247
<i>Macquaria australasica</i>	2	Upper SA section of R. Murray (historically rare).	Zeitl (1902); SAMA F456 (1917), F497 (1918)
<i>Macquaria colonorum</i>	2	Lower Murray, L. Albert, Alexandrina and Coorong.	Eckert & Robinson (1990); Sim <i>et al.</i> (2000)
<i>Maccullochella macquariensis</i>	2	Early record from Purnong on R. Murray. Range extension from upstream populations (e.g. Mildura in 1940-50s).	SAMA 1672 (1932); Cadwallader (1977)
<i>Tasmanogobius lasii</i>	2	L. Albert and Alexandrina (freshwater), apparently spawns in these regions.	Sim <i>et al.</i> (2000); Wedderburn & Hammer (2003)

Species	Record Type	Details	Source
<i>Tinca tinca</i>	3	Once common. Occasionally recorded (e.g. Angas R.).	SAMA F10102 (1999); Sim <i>et al.</i> (2000)
<i>Ammbassis agassizii</i> and <i>Mogurnda adspersa</i>	4	Transferred from Darling R. basin in Queensland to Murray Bridge Army Range, to be later released to R. Murray.	Pierce (1997)
<i>Macquaria novemaculeata</i>	4	Near Loxton, per professional fisher.	SAMA F7169 (1992); Pierce (1992)
<i>Misgurnus anguillicaudatus</i>	4	Unconfirmed report for R. Murray at Long Island. Murray Bridge (1980s). Now spreading downstream from Vic.	Wedderburn; Koster <i>et al.</i> (2002)
<i>Oxyeleotris lineolata</i>	4	Two R. Murray records. Museum specimen from Kroehns Landing (near Nildotte). Another displayed at Swan Reach Hotel, September 2003, caught near Nildotte per professional fisher.	SAMA F10143 (1995)
<i>Salmo salar</i>	4	Three R. Murray specimens caught near Renmark by professional fishers.	SAMA F7284, F7504, F7505 (1993)
SOUTH AUSTRALIAN GULF DIVISION			
<i>Hypseleotris</i> sp. 3	1	Inman R. catchment. Presumed native as sympatric with <i>Nannoperca australis</i> .	Hammer ¹
<i>Nannoperca australis</i>	1	Inman R. catchment, a genetically distinct population of Murray lineage.	Hammer ¹
<i>Anquilla australis</i>	2	South coast catchments of Kangaroo Island.	SAMA F4718, F5175 (1980's)
<i>Craterocephalus eyresii</i>	2	L. Torrens catchment; L. Torrens when full, springs, Willochra Creek.	e.g. SAMA F3176 (1961), F9153 (1996)
<i>Gadopsis marmoratus</i>	2	Historically an edible fish of the Onkaparinga and Torrens rivers. Presence on Kangaroo Island (location unknown) needs verification.	Zietz (1902); SAMA F6467 (1987)
<i>Mogurnda adspersa</i>	2	Historic records for Torrens, Onkaparinga rivers. No reports for >50 years.	SAMA F517, F518 (pre 1917)
<i>Tasmanogobius lastii</i>	2	Lower reaches of Kangaroo Island streams.	Hoese (1991); Hammer pers. obs. 2003
<i>Macquaria ambigua ambigua</i>	3	Introductions do occur (e.g. Clarendon Weir, Broughton R.).	SKM 2002; Bochow (2003)
<i>Maccullochella peelii peeltii</i>	3	Regularly stocked into Broughton R.	e.g. Bochow (2003)
<i>Melanotaenia fluviatilis</i> and <i>Hypseleotris</i> sp. 1	3	R. Torrens, common in lower reaches.	e.g. SAMA F9277 (1999), F9279 (1999); Hammer pers. obs. 2000-2003.
<i>Phlyppodon</i> sp. nov.	3	First record from Onkaparinga R., 2002. Could be native.	SAMA F10087 (2002)
<i>Tandanus tandanus</i>	3	Torrens, Wakefield rivers.	SAMA F9086 (1997); Hicks & Sheldon (1998)
<i>Tinca tinca</i>	3	Few catchments (e.g. Onkaparinga).	SKM (2002); Hammer pers. obs. 1998
<i>Gadopsis marmoratus</i> and <i>Nannoperca australis</i>	4	Refuge population in dams at Warrawong Sanctuary since 1980's (trib. Onkaparinga R.).	Hammer pers. obs. 1999-2002
<i>Galaxiella pusilla</i>	4	Listed without detail.	Carter & Pierce ⁵
<i>Lates calcarifer</i>	4	Netted from R. Torrens (Torrens L.), April 2002 (376 mm total length).	SAMA F00000 [registry number pending]
<i>Mogurnda adspersa</i>	4	Stocked into Thorndon Park Reservoir (since dried).	Anon. (1996)
<i>Salvelinus fontinalis</i>	4	Previously stocked into Sixth Creek, Torrens Catchment.	Scott <i>et al.</i> (1974)

⁴ WEDDERBURN, S. (2000) Habitat and conservation status of small fish in the Lower River Murray, and a comparison of the western carp gudgeon (*Hypseleotris klunzingeri*) and gambusia (*Gambusia holbrooki*) as larval mosquito predators. Unpub. BSc (Hons) Thesis, Department of Environmental Biology, University of Adelaide, Adelaide.

⁵ CARTER, J. & PIERCE, B. (undated) Freshwater fishes of the Mount Lofty Ranges, Department for Environment and Natural Resources, Adelaide, (unpub.), 18 p.

Species	Record Type	Details	Source
LAKE EYRE DRAINAGE DIVISION			
<i>Craterocephalus stercusmuscarum</i>	1	Specimens from the North Flinders Ranges previously identified as <i>C. eyresii</i> . Taxonomic status requires further investigation.	SAMA F7331, F9002, F9078 (1994/95)
<i>Ammiataba percoides</i>	2	First record Neales R. (1984). Common there in 2002.	Glover (1985); Hammer pers. obs. 2002
<i>Carassius auratus</i>	3	Coongie Lakes/Cooper Creek.	SAMA F6199 (1986); Reid & Puckridge (1990)
<i>Cyprinus carpio</i>	4	Leigh Creek retention dam. Poisoning attempted, but still present in 1999 (Hammer pers. obs.)	Pierce <i>et al.</i> (2001)
<i>Maccullochella peelii peeltii</i>	4	Cooper Creek near Innamincka. Population small, may not be viable.	Pierce (1990)
<i>Macquaria ambigua ambigua</i> and <i>Bidyanus bidyanus</i>	4	Stocked into Clayton Bore.	Wager & Unmack (2000)
<i>Percia fluviatilis</i>	4	Introduced to Moto George, Flinders Ranges. Now probably absent.	Glover (1980); Pierce <i>et al.</i> 2001
WESTERN PROVINCE DRAINAGE DIVISION			
<i>Pseudogobius olorum</i>	2	Davenport Creek near Ceduna and Laura Bay.	SAMA F5496 (1981), F7405 (1982)
<i>Atherinosoma microstoma</i>	2	Several regional records (e.g. spring at L. Hamilton; L. Newland).	SAMA 2615 (1947), F4789 (1984)
<i>Pseudaphritis urvillii</i>	2	Streaky Bay (not strictly freshwater habitat but included), most westerly record.	SAMA F1388 (1929)
<i>Gambusia holbrooki</i>	3	Spring at L. Hamilton (extant?).	SAMA F10056 (1947)
<i>Carassius auratus</i>	4	Dams, reservoirs at Woomera (with <i>Gambusia holbrooki</i>).	Glover (1979)

novemaculeata, sleepy cod *Oxyeleotris lineolata* and Atlantic salmon *Salmo salar* in the River Murray. *Gambusia* *Gambusia holbrooki* and goldfish *Carassius auratus* were recorded in all drainage divisions.

Four large native MD species (silver perch *Bidyanus bidyanus*, Murray cod *Maccullochella peelii peeltii*, freshwater catfish *Tandanus tandanus*, *M. a. ambigua*) are spawned in commercial hatcheries in other states and are commonly introduced to South Australia (Tables 2-3), including undocumented stockings in farm dams in MD and SAG.

Translocations in drainage divisions within South Australia are not considered in detail here, but have reportedly included transportation of *M. clivicola* in the Flinders Ranges region and fish from Cooper Creek to a retention dam at Leigh Creek (see Pierce *et al.* 2001).

Extirpations and species decline

Museum records are not necessarily a true indication of range and abundance, but indications from all sources combined are that there have been significant declines in the range of several species. Records for some species may represent occasional stray individuals on the fringe of their geographic range, but these could not be distinguished from established species due to a paucity of detailed historic surveys and/or temporal replication.

There is historical evidence (Table 3) that Murray galaxias *Galaxias rostratus*, trout cod *Maccullochella macquariensis* and Macquarie perch *Macquaria australasica* formerly occurred in MD in South Australia. *Ambassis agassizii* was last recorded from the Marne River mouth (MD) in 1983 (Lloyd & Walker 1986), and state-wide extirpation appears confirmed for the southern purple-spotted gudgeon *Mogurnda adspersa* (last record in MD 1973: SAMA F3727; no sightings in SAG for >50 years). The river blackfish *Gadopsis marmoratus* can be considered extirpated from SAG (it may persist on Kangaroo Island, but the record is dubious: Table 3) and has undergone significant range contraction in MD (Sim *et al.* 2000), exacerbated since 1997 by the loss to irrigation diversions of more than half of the spring-fed habitats in the Marne River, one of few remaining refuges (Hammer 2002b). Similarly, range contraction and on-going local extirpations have been recorded for *N. australis* (Hammer¹). Estuary perch *Macquaria colonorum* was once more widespread in the lower Murray prior to the construction of barrages near to the Murray Mouth (Sim *et al.* 2000). For SEC, *N. cleaveri* and the Australian grayling *Prototroctes maraena* have not been reported since 1974 and 1982 respectively and

other SEC species including *G. pusilla* have likely suffered large range reductions coinciding with massive loss of wetland habitat (Hammer 2002a).

Other species are confined to small areas, including five endemic species in Dalhousie Springs (LE) (Wager & Unmack 2000), *M. clivicola* (recorded only from Balcanoona Creek in the Flinders Ranges (LE): e.g. SAMA F3042), Murray hardyhead *Craterocephalus fluviatilis* (very few sites in the lower Murray (MD): Lloyd & Walker 1986; Wedderburn & Hammer 2003); *N. obscura* (three habitat fragments in SEC and a small section of MD: Hammer 2002a; Wedderburn & Hammer 2003) and the variegated pygmy perch *Nannoperca variegata* (a 4-km² spring-fed area in SEC: Hammer *et al.* 2000).

Discussion

This catalogue is a contribution toward an inventory of state and regional biodiversity. Well-maintained historic collections and voucher specimens are critical to record information, validate doubtful records and sustain progress in taxonomy, ecology and conservation. Ideally, this information should be updated frequently, as work progresses.

Although surface waters in South Australia are limited (NLWRA 2001), the state harbours about one fifth of the continental freshwater fish fauna. As the state borders intersect, rather than enclose, some drainage divisions, and as most divisions allow access to the sea, the number of endemic species is comparatively low. Some 'new' records here arise from minor re-alignments of physiographic boundaries between drainage divisions or states (e.g. South Australian Gulf Drainage Division: *N. australis*; South East Coast Drainage Division: *G. truttaceus*), but others represent significant range extensions (e.g. Murray Darling Drainage Division: *N. obscura*; South East Coast Drainage Division: *N. cleaveri*; Lake Eyre Drainage Division: *C. s. ?stercusmuscarum*).

Biodiversity assessments and monitoring should favour obligate freshwater fishes isolated within particular drainage divisions or regions, because they are most likely to have diverged (cf. Crowley & Ivanstovf 1990a,b; Musyl & Keenan 1992; Larson 1995; Allen & Jenkins 1996; Allen & Feinberg 1998; Hammer¹). These studies may gain impetus from assessments of ecosystem 'health', as fishes are

potential indicators (e.g. Harris 1995). Clarifications are needed in regard to the taxonomy of undescribed taxa, species complexes and the biogeographic status of some species, especially where there are few historical data. Fine-scale molecular markers may help to distinguish natural and translocated populations (e.g. Waters *et al.* 2002).

Alien freshwater fishes are ubiquitous in South Australia. They are most apparent in areas directly affected by human industry, particularly in the Murray Darling and South Australian Gulf drainage divisions. All such species are potential vectors for pathogens and parasites (e.g. Langdon & Humphrey 1987). Predators like brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss* and European perch *Perca fluviatilis* are implicated in the decline of small native fishes (e.g. Crowl *et al.* 1992; Morgan *et al.* 2002). *Gambusia holbrooki* is an aggressive, highly fecund competitor that undoubtedly has affected native species (e.g. Lloyd³). The feeding behaviour and high abundance of common carp *Cyprinus carpio* have contributed to destruction of wetlands associated with the River Murray (e.g. Sim *et al.* 2000), and thereby affected native fishes. There is also some risk of genetic contamination of native stocks by translocated native species (Arthington 1991).

The preservation of native biota is a management priority in South Australia (e.g. Kahrmanis *et al.* 2001; EPA 2003), and avenues for the introduction of non-native fishes such as the government-sanctioned releases of salmonids, sales of fingerling angling species to the public, "conservation" stocking, releases of unwanted aquarium fishes and inter-basin transfers from the River Murray all need review within broadly-based programs of flow and habitat protection, particularly where small isolated populations of native fish occur.

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¹ LLOYD, L. N. (1987) Ecology and distribution of the small native fish of the lower River Murray, South Australia, and their interactions with the exotic mosquitofish, *Gambusia affinis holbrooki*. Unpub. MSc Thesis, Department of Zoology, The University of Adelaide.

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